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positioner can generate high accuracy, small displacement, and high-resolution motion. The moving platform **1204** has the ability to move in translation and rotation about three orthogonal axes.

Three two-degree of freedom deformable structure micro-positioners, as described above, **1201a**, **1201b**, and **1201c** are formed into a monolithic base plate **1202**. Attached at the center of each of the three moving stages are two struts **1203**, for a total of six struts. Each of the six struts is attached to the moving platform **1204**.

The coordinates of the attachment points of the struts to each of the three two-degree of freedom micro-positioners form the base of the device. FIG. **12a** shows the six-degree of freedom micro-positioner in a baseline position. That is, none of the three two-degree of freedom micro-positioners are moved. Reference triangle **1205** is shown to facilitate understanding of movement of each of the three two-degree of freedom micro-positioners. In this baseline depiction, the center of each of the three two-degree of freedom micro-positioners is positioned at a respective one of the three points of the reference triangle. When the moving stage of each of the micro-positioners moves, the size and shape of the base changes, the struts deform and the position and orientation of the moving platform changes.

Using calibration and sensors, the position and orientation of the moving platform is controlled by commanding displacements of each of the three micro-positioners. A controller **1215** processes sensor measurements and input directions to control movement of the moving platform. Movement force generated off of the struts allows the struts to take on any length necessary.

Each of the six struts includes a coupling at either end **1220** **1221**, acting as universal joints to allow rotation and bending. The couplings may be flexures or any other coupling allowing the intended movement.

FIG. **12B** shows the six-degree of freedom micro-positioner moved in pure translation along the X-axis. Unlabeled components are the identical to those in FIG. **12A**. Each of the three two-degree of freedom micro-positioners are moved in pure translation along the direction of the X-axis. The moving platform moves in pure translation in the direction of the X-axis as a result of movement of each of the two-degree of freedom micro-positioners. As shown, each of the three two-degree of freedom micro-positioners are the same distance from their respective point on the reference triangle in the direction of the X-axis.

FIG. **12C** shows the six-degree of freedom micro-positioner moved in pure translation along the Y-axis. Unlabeled components are the identical to those in FIG. **12A**. Each of the three two-degree of freedom micro-positioners are moved in pure translation along the direction of the Y-axis. The moving platform moves in pure translation in the direction of the Y-axis as a result of movement of each of the two-degree of freedom micro-positioners. As shown, each of the three two-degree of freedom micro-positioners are the same distance from their respective point on the reference triangle in the direction of the Y-axis.

FIG. **12D** shows the six-degree of freedom micro-positioner moved in pure translation along the Z-axis. Unlabeled components are the identical to those in FIG. **12A** each of the three two-degree of freedom micro-positioners are moved in pure translation along an imaginary line extending from the respective point of the reference triangle to the center of the reference triangle. The moving platform moves in pure translation in the direction of the Z-axis as a result of movement of each of the two-degree of freedom micro-positioners. As shown, each of the three two-degree of

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freedom micro-positioners are the same distance from their respective point on the reference triangle and along their respective imaginary line.

FIG. **12E** shows the six-degree of freedom micro-positioner moved in rotation about the Z-axis. Unlabeled components are identical to those in FIG. **12A**. The moving platform rotates about the Z-axis as a result of movement of each of the two-degree of freedom micro-positioners. As shown in FIG. **12E**, each of the centers of the three two-degree of freedom micro-positioners are the same distance from their respective point on the reference triangle and together rotated in a counter clockwise direction.

FIGS. **12F** and **12H** show the six-degree of freedom micro-positioner moved in rotation about the X-axis located on the moving platform. Unlabeled components are identical to those in FIG. **12A**. The moving platform rotates about the X-axis as a result of movement of each of the two-degree of freedom micro-positioners. FIG. **12H** shows a side view of the six-degree of freedom micro-positioner rotated about the X-axis.

FIGS. **12G** and **12I** show the six-degree of freedom micro-positioner moved in rotation about the Y-axis located on the moving platform. Unlabeled components are identical to those in FIG. **12A**. The moving platform rotates about the Y-axis as a result of movement of each of the two-degree of freedom micro-positioners. FIG. **12H** shows a side view of the six-degree of freedom micro-positioner rotated about the Y-axis.

FIG. **13** shows a side view of another aspect of the six-degree of freedom micro-positioner. Extending from the base plate **1305** up toward and underneath the moving platform **1306** is extension **1303**. On top of the extension at least one sensor **1301** may be placed. The sensor may monitor, among other characteristics of the six-degree of freedom micro-positioner, translation and rotation of the moving platform. Each sensor may communicate with controller **1215**.

The extension also may have at least one extrusion **1302** to limit displacement of the moving platform. The extrusion or extrusions can prevent the moving plate from tilting beyond a predetermined angle.

It will also be recognized by those skilled in the art that, while the invention has been described above in terms of one or more preferred embodiments, it is not limited thereto. Various features and aspects of the above described invention may be used individually or jointly. Further, although the invention has been described in the context of its implementation in a particular environment and for particular purposes, e.g. micro-positioning, those skilled in the art will recognize that its usefulness is not limited thereto and that the present invention can be beneficially utilized in any number of environments and implementations. Accordingly, the claims set forth below should be construed in view of the full breath and spirit of the invention as disclosed herein.

We claim:

1. A positioning device, comprising:

a support member;

a movable stage; and

a pair of levers disposed symmetric about a first axis of the movable stage and along a line parallel to a second axis of the movable stage, the second axis being perpendicular to the first axis, each lever of the pair of levers being pivotally attached to the support member and the movable stage and configured to receive an input force and to apply a leveraged force, corresponding to the input force, to the movable stage.

2. The positioning device of claim 1, wherein the pair of levers is a first pair of levers, further comprising: